

Supplier Selection via Tournaments

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Abstract

In this paper we study the performance of a sourcing mechanism gaining popularity in industrial procurement environments; a *tournament*. Under a tournament, a buyer initially procures her parts from two suppliers with possibly different quality levels, for T time periods, i.e., she parallel sources. During this time, the buyer is able to observe noisy signals about the suppliers' quality. At time T , she selects the supplier with the highest observed performance and awards it the remainder of her business. We characterize the optimal duration of the tournament as a function of various market parameters, including information and investment costs. Furthermore, we demonstrate that a tournament can be more profitable for the buyer than selecting the highest quality supplier at time $T = 0$ and sole sourcing entirely.

Keywords: Parallel or Dual sourcing, procurement, quality, asymmetric information, investment.

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1 Introduction

As a growing number of companies are increasing their reliance on outside suppliers for integral inputs into the production process, the *supplier selection mechanisms* used to select these critical suppliers is increasingly important. Particularly in high-tech and manufacturing industries such as electronics, aerospace and automotive, a supplier can greatly influence the final quality of a buyer's product, via the supplier's technology capabilities, skilled worker base, reliability of delivery and product reliability.² While there are varying opinions as to the relative importance and effectiveness of different types of quality control measures, corporate and societal cultures (Yeung et al. (2005)) in achieving high quality products, there is no disputing that the quality of suppliers, their willingness to invest in new technology and flexibility in responding to the marketplace and buyer's demands are critical for the final success of a buyer-supplier relationship.

While the importance of a supplier's quality, e.g., leadtime, during the supplier selection process is a widely acknowledged and studied area in operations management (e.g., Yan et al. (2003) and Tempelmeier (2002)), this literature generally assumes that the supplier's quality level is fixed and exogenously determined and is known to both the buyer and supplier; under this setting the papers study how to optimally purchase from the set of existing suppliers. That is, there is no asymmetry in information between the buyer and suppliers concerning their quality levels. In contrast, in high-tech and manufacturing setting where quality is of pivot importance, a supplier's quality level is often unknown (or imperfectly known) to the buyer and suppliers. Furthermore, a supplier is often able to improve his quality by making investments in the relationship, for example, by training his employees or investing in new and better equipment. While the buyer would like the supplier to undertake costly investments in the relationship so as to improve his quality, the buyer is rarely willing to pay the supplier for these investments.³ Ideally, the buyer would be able to perfectly assess the suppliers' quality and select the optimal investment levels for the suppliers to undertake. However, buyers who do not "foot the bill" for desired investments are rarely able to dictate and perfectly observe the suppliers' investments, i.e., the suppliers' investments are unobservable and unverifiable. This asymmetry in information implies that a buyer who faces a set of suppliers of

²One need only point to the unfortunate events between Ford Motor Company and Firestone Tire company to understand the critical importance of these quality attributes in a buyer-supplier relationship (Stimson et al. (2000)).

³For example, buyers are often worried that supplier-improving investments will be shared with other customers, and therefore are reluctant to pay for them (Caltabiano (2001) and Wong (2001)).

unknown quality and unobservable investments must design a sourcing arrangement that allows her to both extract some information about the suppliers and encourage (costly) investments on their part.

One method used by the Department of Defense, Solectron, and Toyota⁴ (amongst others) to identify high quality suppliers and provide them with the incentive to improve their quality is to initially dual (parallel) source with (possibly new or incumbent) suppliers. As the buyer observes the suppliers' quality (via, for example, his output), the buyer begins to redistribute her business among the suppliers by increasing her reliance on observed high quality suppliers. The buyer may choose to terminate her business with one (or more) observed low quality suppliers. By awarding greater portions of her business to a well-performing supplier, the buyer creates a tournament in which the suppliers compete for the "prize" - a larger share of the buyer's business. This type of sourcing arrangement can be a tremendous success for the buyer. In the 1970's, the Department of Defense found itself saddled with a highly defective/low quality F100 engine produced by Pratt and Whitney. As the sole producers of this engine, Pratt and Whitney were unresponsive to the Air Forces pleas for a higher quality product. In order to combat Pratt and Whitney's complacency, the government decided to outsource a portion of its engine business to General Electric. The government made each company's share of future business contingent on its products' quality and performance. The resulting increase in quality due to competition was tremendous. In testimony before the House Appropriations Subcommittee on Defense in 1979, General Lew Allen, Air Force Chief of Staff, explained: "We are concerned about the motivation and incentive of Pratt and Whitney to correct this engine....[The] best way to insure that we were adequately addressing the problem was to generate some competition....The approach with General Electric...is an attempt...to develop a true competitive situation within the engine industry." (Drewes (1987) pg. 145).

In this paper, we consider a stylized model of this supplier selection mechanism and evaluate his optimal structure and performance. We consider a buyer who faces two types of suppliers with possibly different quality levels. The buyer would like to procure her parts from the highest final quality supplier, where final quality is determined by a supplier's current quality and any costly investment undertaken as a result of the buyer-supplier relationship. The buyer is considering using a tournament of duration T ; namely, the buyer will parallel source from both suppliers and observe

⁴See Richardson and Roumasset (1995) and Treece and Rehtin (1997) for a brief discussion of Toyota's parallel sourcing experience.

signals of their quality level for T time periods and then award a sole sourcing contract for the remainder of her demand to the supplier who exhibits the highest quality level.

As independent entities, both the buyer and suppliers will behave strategically and act in their own best interest. Acknowledging this, a buyer must take into account the supplier's private information and strategic behavior when selecting and designing a supplier selection mechanism. Using game theory, the three main questions this paper seeks to answer are:

- What is the relationship between suppliers' investment levels and T ?
- How do the information in the marketplace and cost structure of investment affect the optimal T ?
- How do the information in the marketplace and cost structure of investment influence the effectiveness of a tournament?

Via numerical analysis, we compute the optimal duration of the parallel sourcing period as a function of the supplier characteristics. We are able to provide insights into how the suppliers' optimal investment levels are affected by the choice of T , the suppliers' qualities, cost of investment and the "noisiness" of the quality signal, as well as the probability that the buyer incorrectly selects the low quality supplier at time T .

We find that the benefits of a tournament during the selection process are two-pronged. As stated before, the buyer often does not know the suppliers' qualities, hence parallel sourcing gives the buyer a chance to observe and learn more about the suppliers' qualities. In addition, parallel sourcing improves the buyer's profitability via heightened competition among suppliers. Interestingly, we find that even if the buyer were able to perfectly assess the suppliers' quality and choose the highest one, she may still prefer to parallel source from both suppliers for some portion of time. This is due to the "tournament" structure of the procurement mechanisms and the positive effect that increased competition has on the supplier's willingness to invest. Furthermore, these results hold whether the suppliers' investment decisions are fixed (one-time irreversible decision) or variable (the supplier can select his investment level at more than one point in time).

The organization of the rest of our paper is as follows. In section 2, we provide a description of our problem. We review the relevant literature on tournaments and competition in procurement mechanisms in section 3. In sections 4- 6, we examine the equilibrium of the tournament game